DOCUMENT RESUME

ED 382 249 JC 950 231

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TITLE	Mastermind: An Activity for Becoming Aware of Negative Mental Sets.
PUB DATE	23 May 94
NOTE	19p.; Paper presented at the Annual International Conference of the National Institute for Staff and Organizational Development on Teaching Excellence and Conference of Administrators (16th, Austin, TX, May 22-25, 1994).
PUB TYPE	Reports - Descriptive (141) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Class Activities; Community Colleges; Critical Thinking; *Educational Games; *Mental Rigidity; Outcomes of Education; *Psychology; *Student Attitudes; *Student Reaction; Two Year Colleges; Two Year College Students
IDENTIFIERS	*Mastermind (Game)

ABSTRACT

Since 1974, the game, Mastermind, has been a partial requirement for an introduction to psychology course at Arizona Western College. The game is designed to help students become aware of negative mental sets and apply critical thinking skills, and requires students to duplicate a code consisting of four different colored pegs arranged in a particular order. With each attempt to solve the code, they are given feedback via white and black pegs to provide information for subsequent attempts. Students play until they complete three games and then write a paragraph describing the relationship of the game to psychology. Outcomes were analyzed for 335 students completing the course and the Mastermind requirement between fall 1980 and spring 1982 and for 141 completing between summer 1992 and spring 1993. Results included the following: (1) for both groups, 69% had never played the game before, but experience with the game was not shown to have a significant effect on fulfilling the outcome; (2) with respect to the number of games needed to reach three successful attempts, the mean, median, and mode for both groups were all between four and five games; (3) regarding the relationship of the game to psychology, 50% of the first sample cited its relation to logic or thinking, compared to 39% of the second group; (4) 14.3% of the first, and 12.8% of the second, found a relationship to negative sets of thinking; and (5) for both samples, 59% thought the game was worth the time and effort, 28% did not think so, and 13% did not respond. (The Mastermind student questionnaire and background information on the game for tutors are appended.) (KP)

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Mastermind: An Activity for Becoming Aware of Negative Mental Sets

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JC 950 231

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MASTERMIND: An Activity for Becoming Aware of Negative Mental Sets.

ABSTRACT: All of us develop mental blocks (negative mental sets) that interfere with our lives. Students develop similar mental blocks that interfere with understanding concepts, doing various tasks, and/or maintaining social relationships. Many of us are not even aware that these mental blocks exist. Unlike most situations, playing *Mastermind* can provide empirical evidence of these mental blocks, so they can be corrected.

Since 1974, playing *Mastermind* has been a partial requirement for an *Introduction to Psychology* course. In the game, students must duplicate a "code" consisting of four different colored pegs arranged in a particular order. With each attempt to solve the code, they are given feedback via white and black pegs to provide information for subsequent attempts. Students may play as many games as needed to successfully complete three games. Success is defined as duplicating the exact peg arrangement within six attempts. Then the student must write a paragraph indicating how this game relates to psychology.

About 15-20% of students become aware of mental blocks. The majority see the game as related to a need for logical thinking. Others relate the game to the importance of feedback, the need for perseverance in the face of initial frustration, the development and revision of hypotheses as in the scientific method, etcetera.

Most important, this is a student-generated conclusion, not one offered by some authority figure. By doing the activity themselves and coming to their own conclusions, their conclusions can be incorporated into their thinking processes as a positive mental set.

MASTERMIND: An Activity for Becoming Aware of Negative Mental Sets

Presented at NICOD CONVENTION, MAY 23, 1994

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PURPOSE: To provide an experiential activity for becoming aware of negative mental sets and using critical thinking skills.

"Tell me and I forget,
Teach me and I remember,
Involve me and I learn."

Benjamin Franklin

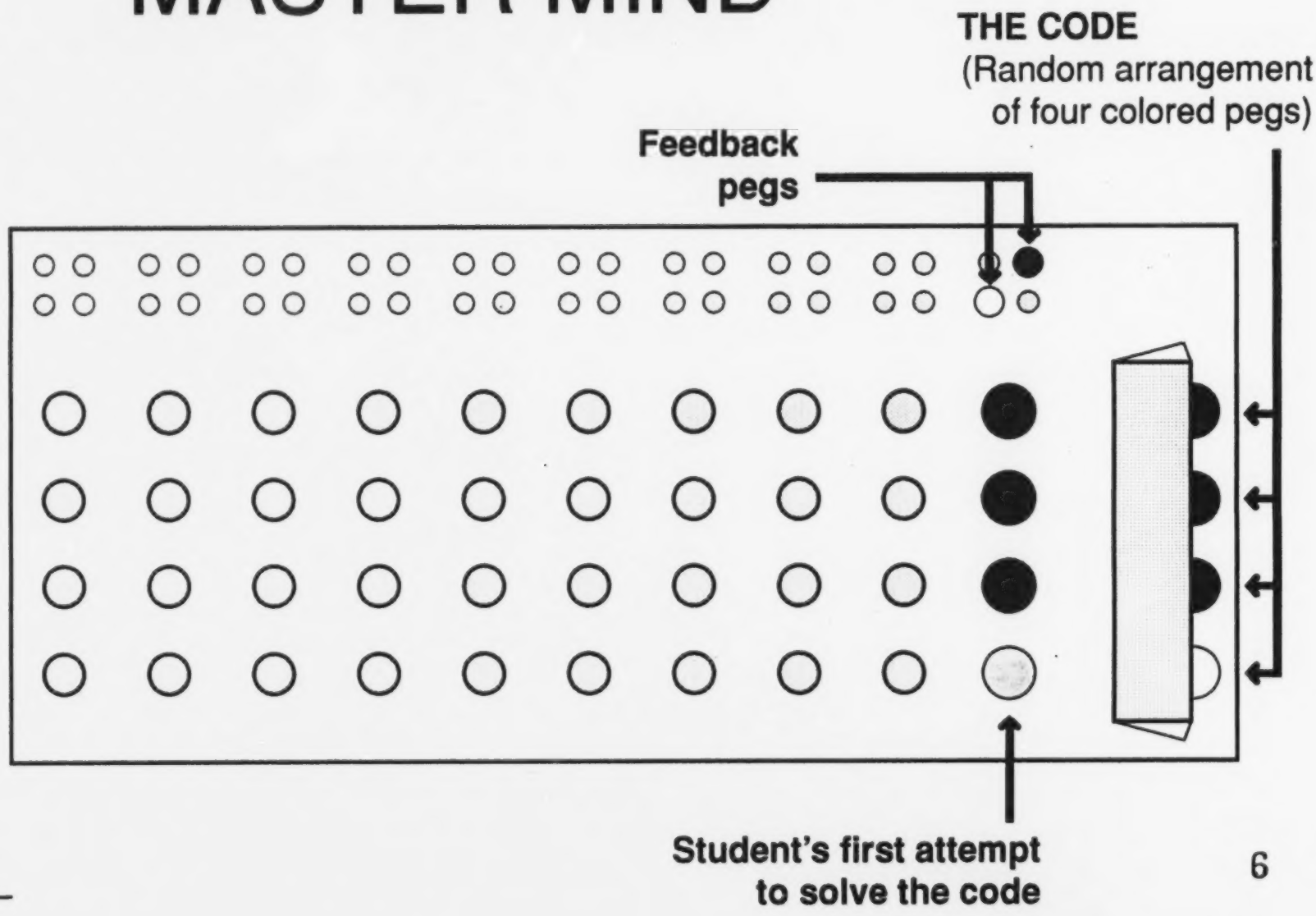
INTRODUCTION: All of us develop mental blocks (negative mental sets) that interfere with our lives. Students develop similar mental blocks that interfere with understanding concepts, doing various tasks, and/or maintaining social relationships. Many of us are not even aware that these mental blocks exist. Unlike most situations, playing *Mastermind* can provide empirical evidence of these mental blocks, so they can be corrected.

METHOD: Since 1974, playing *Mastermind* has been a partial requirement to earn credit for *Introduction to Psychology 101.* (This is an essentially nonverbal game made by Invicta Plastics Ltd, Leicester, England, with offices in the United States at 200 Fifth Avenue, New York.) In the game, students must duplicate a "code" consisting of four different colored pegs arranged in a particular order. With each attempt to solve the code, they are given feedback via white and black pegs to provide information for subsequent attempts. Students may play as many games as needed to successfully complete three games. Success is defined as duplicating the exact peg arrangement within six attempts. Then the student must write a paragraph indicating how this game relates to psychology. (See scoring sheet in Appendix 1.)

Insert Figure about here.

For my course, either I or my tutors are available outside of class hours to play with the students. I am available before and after my off-campus classes, while specially-trained tutors are available for on-campus students at our *Learning Assistance Center* during their hours: 7 A.M. to 8 P.M., Monday through Thursday. (For specific instructions that the tutors receive, see Appendices 2 and 3.) In the class syllabus, it is clearly stated that credit cannot be obtained for the course, unless this requirement is completed before the last day of classes. (The total time to com-

MASTER MIND



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plete this requirement averaged about one hour. However, this varied greatly among students, depending on how quickly they made decisions and how much they vacillated after making decisions.)

Mastermind is used in an alternate way for workshops. In the workshops, after being given the instructions on how to play the game, a minimum of three students are assigned to each *Mastermind* set. One plays the game, another provides the feedback, while the third (or more) act as spectators. The spectator's responsibility is to observe what is happening and correct the person giving the feedback, if necessary. After the player finds the code or a period of time passes (approximately ten minutes), the students rotate positions. After the next solution or ten minutes, the students rotate again. With ten sets, 30 students can participate in about a half hour. Once all the students have been in each position, the playing is stopped. Then they are asked to discuss what they have learned from playing the game.

RESULTS: The data for students who played this game were gathered both in 1983 and 1993. The 1983 information was analyzed from 335 students, all who completed *Mastermind* in the two years from Fall, 1980, through Spring, 1982. This sample included 185 males and 150 females. The ages were positively skewed from 15 to 63, with a median age of 20.9. This compares with the 1993 group of 141 students in the year from Summer, 1992, to Spring, 1993, which included 55 males and 86 females. Their age distribution was also positively skewed, ranging form 17 to 50, with a median of 22.7. (Note that in approximately ten years, the proportion of women and the median age have both increased.)

Coincidentally, in both groups, 69% had never played *Mastermind* before. Previous experience with the game did not make any significant difference in fulfilling this requirement.

The number of games needed to reach three successful games was positively skewed with a range from 3-14 for the first sample and 3-13 for the later group. With both samples, the mean, median and mode were all between 4-5 games. In addition, 97% of the first group of students completed the requirement in eight games or less, while that percentage was 96% for the later group.

Only the first group was analyzed to see if age correlated with the number of games needed for three successful games. There was a significant, but small relationship ($r = +.15$, $P = .003$). This suggests a slight relationship between aging and negative mental sets.

After successfully completing three games in six rows or less, the students must answer the following questions in a short paragraph.

"Why do you think Dr. Gershaw had you play MASTERMIND as a requirement for his psychology class? In other words, how does this game relate specifically to psychology?"

As much as possible, the responses of the students were grouped into categories. If more than one conclusion was given, either the first-mentioned or the most-elaborated one was used to define the designated category. These categories are shown for the first group below.

Categories of Student Conclusion	N	%
Logic or Thinking	168	50.1
Negative Sets	48	14.3
Frustration or Stress	30	9.0
Feedback	11	3.3
Trial and Error	11	3.3
Do Not Know	10	3.0
Other	57	17.0
Total	335	100.0

Although both groups were relatively similar in many ways, they differed most in their relating *Mastermind* to aspects of psychology. The categories for the 1992-1993 group are shown below.

Categories of Student Conclusions	N	%
Logic or thinking	55	39.0
Negative Sets	18	12.8
Information Usage	17	12.1
Feedback	19	13.5
Frustration or Stress	9	6.4
Other	23	16.3
Total	141	100.1

"Logic or thinking" in both groups relates to some aspect of logic, deduction, analysis, or merely thinking a problem through. (Because learning how to think was greatly emphasized in the classroom, this may account for the popularity of this conclusion.)

For both groups, "Negative Sets" indicated responses like being "sure" an incorrect colored peg was right. Essentially this is being confident — but wrong — in making decisions. In turn, the negative sets lead us to ignore information that is there, because it does not match our previous assumptions. In the later group only, a significant proportion ("Information Usage") indicated that all the available data needs to be used, or that one needs to make use of past experiences, but they did not directly mention the problem of "Negative Sets". If these two categories are combined, this means that almost one-fourth of the students became aware of some aspect of the problem of negative sets.

In dealing with the next two categories, "Frustration or Stress" and "Feedback," their relative importance became switched in terms of frequency. "Frustration or Stress" deals with concepts like Selye's General Adaptation Syndrome, the Yerkes-Dodson Law or specific responses to frustration. Although the above concepts were talked about or implied, they were only rarely named. "Feedback" refers to finding out immediately if you are right or wrong in terms of your responses. Apparently, playing *Mastermind* was less stressful and frustrating for the later group.

The "Trial and Error" and "Do Not Know" responses were only given in high enough frequency to be distinct categories with the first group.

"Other" included various responses given by only a few students in either group. These indicated such aspects as empirical evidence, concentration, intelligence, creativity, personality assessment, memory, learning, attention, planning ability, making choices in life, building on our own mistakes, self-actualization, and the scientific process.

Some examples of student responses from the 1992-1993 sample follow:

> "When I first came in here, my anxiety level was pretty high. After I started playing and getting used to the game, I calmed down and my level of anxiety lowered. I played better because complex tasks require a low level of anxiety. Also, the way I received feedback and reinforcement helped me make better guesses."
>
> Female, 33, Elementary Education

> "Dr. Gershaw had us play Mastermind, so we can see how various things apply to psychology. A few things I related this game to is the random search strategy (p. 283) and mental sets. The reason it relates to random search strategy is because you seek a combination (of colored pegs) with a limited number of possibilities. Mental sets play a part, because if you misinterpret your feedback, you may think one color is correct, when it really isn't."
>
> Male, 18, Administration of Justice

> "Mastermind seemed to be a waste of time. I took on such criteria as another little block of time that the instructor takes from my week. However, <u>learning</u> the game and how to use previous information is a helpful process. I could see a strategy and start to apply logic, and I discovered the enjoyment of the game. I still think that I would rather not have been required to

play, but I did get something beneficial out of it. It feels good to use my brain again."
Female, 25, Education

"On a general scale, this game can be thought of as a lesson in life. It's only natural to make an occasional mistake in life; when a person continues to make mistakes throughout life, that will only complicate day-to-day living. One of the reasons history is taught in our schools is to learn from our mistakes."
Male, 20, Education

"Being mean is too juvenile an answer, and now that I'm at the close of the semester, I see his purpose is to make each player think. All of the information was right there in front of me, but I chose to ignore it. Dr. Gershaw continued to reinforce the fact that all the information was there, until I finally caught on and completed the assignment."
Female, 30, Nursing

"Personally, I believe it helps one get out of mind "sets". It made me concentrate on the information before me and come to a given conclusion. (And when I achieved the assignment, it made me feel as if I had accomplished something — it was gratifying!)"
Female, 30, Social Science

Because of some student comments in the 1992-1993 group, the reaction of students to *Mastermind* was also requested in the course evaluation at the end of the course. Because responses were anonymous, they cannot be correlated with other demographic information or responses to the Mastermind game. Among other questions used to evaluate the course, students were given the following item.

"Was the *Mastermind* game worth the time and effort it took to complete that requirement? As specifically as possible, indicate why."

The responses to the question are listed below. A fair proportion answered either "yes" or "no" without elaborating about their reasons.

Yes --------- 59%
No --------- 28%
No Response - 13%

Generally, those who answered "yes" indicated that they learned something beneficial from the assignment and/or liked the variety

it provided. Those who answered "no" were more likely to indicate that (1) they were not sure of, or did not know, the reason for the assignment or (2) this out-of-class assignment was an unwanted, extra burden in an already overloaded schedule.

CONCLUSIONS: About 14-25% of students come to a conclusion that relates to negative sets, fixations, or even delusions. Frequently a student seems to fixate on one color, so s/he ignores any feedback that contradicts the use of that color. At the end of the game, when the code is revealed, the student can see that their favorite color was never there. There is no way the tutor or myself could have removed that peg, while the student is physically present. (Unfortunately, the computerized version of this game does not have this limitation.)

In social situations, if someone thinks something is one way but it is not, there is very little you can do to convince the person otherwise. For example, if someone thinks you don't like them, how can you convince them that you really like them and are not just pretending? However, with *Mastermind*, the data are more empirical. The student can look back and see where s/he has not used information that was available, because s/he was fixated on a hypothesis related to a specific color. These students begin to realize that once you have made your mind up about something, you will tend to ignore data that conflicts with your decision. Since their conclusions are self-generated from a personal experience, rather than being told to them by an authority figure, the conclusions are more likely to be remembered. I hope it makes them a little more open-minded.

There is another advantage. I (or my tutors) play with students, usually on a one-to-one basis. We get to know them better, and they get to know us better. It tends to make them feel more comfortable in coming to us with questions or asking for help.

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Appendix 1
MASTERMIND

NAME _____ AGE _____

SEX M___ F___ Class Section # _____ Major_____

Have you played MASTERMIND before? _____ Yes _____ No

Game Number	Trials to solution	Date	Tutor's Initials
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

(If more games are played, use the back of the sheet.)

After you have completed three games in six trials or less, answer the following questions in a short paragraph.
Why do you think Dr. Gershaw had you play MASTERMIND as a requirement for his psychology class? In other words, how does this game relate specifically to psychology?

LEARNING ASSISTANCE CENTER
Appendix 2
MASTERMIND INSTRUCTIONS
FOR TUTORS

I. Either have the student read the written directions for the game or tell them to the student. If you tell them to the student, please include the following data:
   A. Any combination of four pegs can be used, but the pegs will be picked on a random or chance basis. When you pick the pegs, it is better to do this with your eyes closed, so this is true.
   B. In relation to the small black and white feedback pegs:
      1. A white peg means that one of the four pegs is the correct color but in the wrong position.
      2. A black peg means that one peg is the correct color in the correct position.
      3. Feedback holes with neither black or white pegs indicate that the corresponding number of pegs are the wrong color.
      4. The position of the feedback pegs in the four holes has no significance.

II. Do not place any feedback pegs, until all the colored pegs have been placed and the student has indicated that it is the desired order. If in doubt, ask the student.

III. While the student is placing the pegs, do not give *any* verbal or nonverbal feedback (e.g., sighing, exhaling, asking questions, rolling your eyes, looking for feedback pegs, etcetera). This will be the *hardest* part of playing this game with students.

IV. If the student does not get the correct arrangement in 6 trials or less, have the student continue to try and find it. If the student does not get the correct arrangement in 10 trials, let them quit and mark "10+" on their form for that game.

V. After the student has passed 6 trials on any game, you may ask general questions like, *"Does that fit the previous information you have?"* Do not ask these questions until after they have placed all four pegs for the next trial. Whatever their conclusions, give a non-committal answer like, *"That's a possibility,"* or probe further with, *"Why do you think that is correct?"* Let the students make their own mistakes!

VI. Only after students have completed the game, successfully or not, should you show them the information they seemed to ignore.

VII. Record all games and make sure all information is included in their forms. If the student does not know or refuses to give

information, record that in the appropriate space.

VIII. Remind the students not to play any practice games that are not recorded on the form.

IX. Depending on the decision speed of the students, one tutor can easily play the game simultaneously with 3-4 students.

X. If you have any questions about the game, feel free to contact me in my office or wherever you see me. Thank you for your cooperation.

David A. Gershaw, Ph.D.
Professor of Psychology

Appendix 3
Introduction to Psychology 101
Directions for Mastermind Tutor

(This is to insure greater standardization for this requirement.)
(Verbatim directions are in quotes and boldface.)

(Before starting, make sure the student fills out the necessary forms, giving all the requested information. Then bring the **Mastermind** game out of the box in front of the player.)

"The object of this game is to duplicate exactly the color and arrangement of pegs that I put in here." (Gesture to appropriate area on the board.) **"It is something like finding a code. I will randomly choose four pegs and put them here in any order. For example, suppose I pick these four pegs."** (Randomly grab a handful of pegs, then eliminate pegs from your hand, so four pegs remain and put them in the correct position. Two of the pegs should be the same color for demonstration purposes.) **"Remember, you will not see the pegs I pick."** (Put the cover over the pegs you have inserted.)

"Now suppose you pick these four pegs on your first try to guess the code." (Pick four pegs — two the same color as the "double" you put in your code and two from colors that are not in the code. Place one of the duplicated pegs in the correct position and one in the wrong position.)

"To give you feedback, I will insert the feedback pegs over here." (Gesture to appropriate area of the board.) **"If I put in a white peg** (Insert white peg.), **this means that one of these pegs** (Gesture over all four pegs of the first try.) **is the right color but in the wrong position. The white peg indicates that one *peg* is the correct color but in the wrong position. What does the white peg mean?"** (Correct the student's response as appropriate, making sure that s/he indicates that each feedback peg stands for a peg rather than a color.)

(Insert black feedback peg.) **"The black feedback peg means that one peg** (Gesture over all four.) **is the correct color and in the correct position. The black peg means that one *peg* is the right color in the right position. What does the black peg mean?"** (Correct the student's response as appropriate, making sure that s/he indicates that each feedback peg stands for a peg rather than a color.)

(Gesture to the empty spaces in the first feedback area.) **"Each empty space indicates that one *peg* is completely wrong — it does not belong in the code. What does an empty space**

mean?" (Correct the student's response as appropriate.)

"Where I put the feedback pegs in the four spaces has no meaning at all. (Reposition one or both of the feedback pegs.) **This has exactly the same meaning as it did before."**

"Once you get your feedback, you then use this information on your second trial. (Gesture across the second row.) Once you have put all four pegs in the second row, I will give you appropriate feedback pegs. (Gesture to second feedback area.) **Then using the information from both your first and second trials, you put in your pegs for your third try."** (Gesture appropriately.)

"You need to continue this process until you have exactly duplicated the code or until you have completed ten trials. The object is to duplicate the exact colors and positions of the pegs in six or less trials for three times. If you do not get the exact code in six trials, Dr. Gershaw wants you to continue until you duplicate the code exactly or complete the tenth trial. Do you have any questions?" (Whenever possible, answer the questions by repeating the appropriate portion of the original directions.)

"Just to show what the feedback pegs mean, let's look at the first row. (Uncover the code and point to the black feedback peg.) **The black peg stands for this** (Name color.) **peg, telling you it is the right color and in the right position.** (Point to the corresponding peg in the previously hidden code.) **Likewise, this white peg** (Point to the white feedback peg.) **stands for the other** (Name color.) **peg, telling you it is the right color, but it is in the *wrong* position.** (Point to the corresponding peg in the code.) **Each blank space in the feedback area** (Point to the blank spaces.) **indicates that one peg is wrong.** (Point to the incorrect pegs in the first row.) **Do you have any questions now?"**

(Once the questions are answered, ask the student to turn around so you can insert the four pegs for the first game. Randomly grab four pegs and insert them into the appropriate area, cover the code, ask the student to turn to face you, and begin playing.)

(For the first few trials, ask the student to tell you what the feedback means — until s/he has given you indications that s/he clearly understands what both the white and black feedback pegs mean.) **"What does this mean?"** (Gesture to the feedback area. Correct responses as appropriate. Make sure that they also indicate the meaning of the blanks feedback spaces. If the only explain part of the feedback, ask **"And?"** while gesturing to the feedback peg(s) or blank spaces that have not been explained. Once

they indicate that they understand the meaning of the feedback, do not ask any more questions during the first six trials of any game.)

(If the student has inserted all four pegs and is just sitting there, so you don't know whether they have finished their trial or not, you may ask, **"Are you done?"** or **"Is this what you want?"** The first time you do this, you might want to indicate, **"My question has no relationship to the correctness of your arrangement. I just need to know if this is the arrangement you want."** (Do not start to position feedback pegs, until you are sure that the arrangement of pegs for any trial is the one the student wants.)

(Once the student has completed six trials, you may ask them questions to make them aware of what mistakes they may have made like, **"In this row, how many pegs are the correct color? Now, how many pegs from that row did you use in this** (later) **row?"** If the student gives an incorrect number, you can ask the student to name the colors used in both rows, so s/he can become aware of the actual number used. Otherwise, accept any answer the student gives you with comments like, **"That is a possibility."** or **"That's one way of looking at it."** Above all, let the students discover their own mistakes!)

(If the student does not seem to grasp the basic strategy of the games after playing a couple of games — in other words, it takes 10 trials and they do not achieve the code — you may tell them, **"For any row to have the chance of being completely right, it must match *all* the information in *all* the rows."** If a student still does not seem to grasp the strategy, you can offer to reverse roles, so you play the game and the student provides the feedback. While you are playing, you can think out loud, so the student can grasp the basics of the game. However, make sure to indicate that your strategy is only one way of obtaining the correct code.)

(If the student questions the accuracy of the feedback, check the feedback pegs out loud, row by row, **"The feedback for row one is correct. Row two is correct."** and so on. If you do discover a mistake, correct it and apologize. If the mistake is in one of the earlier rows, the student may be allowed to start a new game without finishing the current one, but do not record the incomplete game on the Mastermind form. If, for any other reason, the student refuses to complete a game, mark the number of rows with a plus sign (e.g., "8+") on the Mastermind form to indicate that the code has not been solved.

(Whenever the student correctly duplicates the exact color arrangement of the pegs, turn over the cover of the code and

enthusiastically congratulate him/her. You can even shake his/her hand, if you want.)

(Once the student has finished the game, mark the number of trials, the date, and your initials on the appropriate parts of the Mastermind form. Ask the student, **"Do you want to play another game?"** If the student declines, place the Mastermind form in the "Mastermind in Progress" folder.)

(Once the student has completed three games in six trials or less, indicate that they need to answer the questions on the bottom of the Mastermind form. If they decide to it at a later time, put the form in the "Mastermind in Progress" folder. Once they have finished the answer, indicate to the student that their Mastermind obligation is complete and put their form in the "Completed Mastermind" folder.)

If you have any other questions about playing Mastermind, either ask the person who is training you to play Mastermind or Dr. Gershaw. Thank you.